

BLACK & VEATCH

South Florida Water Management District
EAA Reservoir A-1 Basis of Design Report

January 2006

APPENDIX 5-14
LITERATURE REVIEW

TECHNICAL MEMORANDUM

South Florida Water Management District
EAA Reservoir A-1
Work Order No. 3

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Task 5.3.5.3 Literature Review

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To: Distribution

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1. OBJECTIVE

The overall objectives of the Wave Run-up Model are as follows:

- To determine the amount of freeboard required to prevent over-topping of the reservoir embankment during high wind and rain conditions,
- To determine the effectiveness of internal breakwaters in decreasing wave run-up.

This memorandum summarizes one of the tasks completed in developing the Wave Run-Up model and includes the results of a literature review to search for site-specific information on freeboard requirements and the effectiveness of wave run-up models. The primary focus of the literature review was identifying information on procedures used to determine freeboard requirements and how the reservoirs have reacted to hurricane or strong wind conditions.

2. METHODOLOGY

Several sources were examined to obtain data and information pertinent to this task. Searches were conducted using the following search engines, databases and websites:

- US Army Corps of Engineers (USACE) website
- Federal Emergency Management Agency (FEMA) website
- South Florida Water Management District (District) website
- United States Society of Dams website
- Everglades plan website

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- Google
- Altavista
- Florida Universities library databases
- Georgia Institute of Technology library database

In addition, personnel from the following agencies were contacted for information.

- Jacksonville District of the US Army Corps of Engineers
- Mobile District of Corps of Engineers
- United States Society of Dams (USSD)
- Association of State Dam Safety Officials

3. RESULTS OF LITERATURE REVIEW

The information sought during this literature review can be divided into two categories:

- freeboard requirements
- site-specific information on procedures used to determine freeboard and how the reservoir reacted to hurricane or high wind events, i.e., was the freeboard sufficient.

Freeboard requirements for various types of levees and reservoirs have been established by the USACE and FEMA and are summarized in the following section. Unfortunately, as discussed below, very little site-specific information was found during the literature review.

Information on the models and methods available to determine wave heights and wave run-up was also obtained during a previous task. This information was presented to the District in Work Order 3, Technical Memorandum No. 1, submitted on December 29, 2004.

3.1 *Freeboard Requirements*

As stated in by USACE (1991) the objective in selecting the freeboard design is to assure that failure of the dam or levee will not result from wind set-up, wave action, uncertainties in analytical procedures, and uncertainties in function, in combination with the most critical pool elevation. Some over wash can be allowed but it is not to be of the magnitude or duration as to threaten the safety of the impoundment. General freeboard requirements for reservoirs are presented in USACE (1997). Reservoirs with surcharge above the full pool level require a minimum of three feet of freeboard if wave overtopping does not endanger the impoundment. As for reservoirs that have surcharge pool elevations within three feet of the maximum pool level for 36 hours or longer the minimum freeboard for embankment dams is five ft.

In designing a freeboard, the three most influential factors are wave characteristics, wave run up, and wind setup. Each must be taken into consideration to calculate the amount of freeboard that will be needed to prevent flooding. The sum of the three represents the highest water level that the reservoir will reach under the conditions specified.

When modeling, using the highest water level in combination with the highest wind velocity can be overly conservative, because the probability of both of these occurring together is extremely low. For this reason using the maximum water level and a mid range wind speed is advisable.

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To attain permits for the reservoir and freeboard, an Inflow Design Flood (IDF) routing must be performed. The CERP design manual states that the IDF determines the most critical pool elevation or surcharge. The estimates derived consist of hypothetical flood hydrographs that are developed from rainfall intensity, duration, area relationships and runoff characteristics. After a 6hr and 72hr Probable Maximum Precipitation (PMP) analysis is completed, an analysis for a range of floods and Standard Project Flood storm including PMP and a cost versus risk analysis on the resulting levee height requirements should be completed.

CERP impoundments are not considered classic dams because they do not obstruct a channel or discharge into a historic river channel. Therefore some assumptions are made when modeling a breach. The results of the dam break analysis should include graphs and tables illustrating the maximum water velocities and water depths versus distance from the breach. These results are then to be compared to the figures provided in the US Dept. of Interior Bureau of Reclamation's *Downstream Hazard Classification Guidelines* for hazard probability concerning public safety.

3.2 Site-specific Information

Very little site-specific information on reservoir design criteria for freeboard was found during the literature review. Only one example was found that stated the reservoir characteristics and the design conditions used for the freeboard calculations. The Tampa Bay reservoir holds approximately 15 billion gallons of water and varies in depth from 35 to 65 feet. This reservoir is almost all above ground and has a freeboard of 8.5 feet. The freeboard was designed for the wave run-up associated with winds of 110 mph and 40 inches of rainfall. This was considered to be a conservative freeboard design.

Other examples were found that provided information on the reservoir characteristics, freeboard or additional storage capacity but did not provide the wind and rainfall amounts used to develop the design criteria. The Hartwell Lake reservoir is 56,000 acres in size and is located along the border of Georgia and South Carolina. It was designed with a freeboard of 5 feet which was determined from models using a 100 year storm. The Piney Point reservoir, in northern Manatee County, Florida, is designed to store approximately 698 million gallons of water. It is located in northern Manatee County in Florida. In case of emergency the reservoir can store up to 919 million gallons of water; enough extra capacity to accommodate a 100 year, 24 hour storm.

Information on one reservoir's reaction to a hurricane was also found. The Palm Beach Aggregate reservoir in Florida had grassed side slopes and a depth of approximately 55 feet. The slope was in the order of 3H:1V. This reservoir is mostly underground and has a bottom elevation of approximately negative 40 feet NGVD. The top of the levee is 23 feet NGVD that is about 8 feet above ground surface. When Hurricane Jeanie hit the reservoir the water level was about 10 feet NGVD. The reservoir has a fetch of about 1 mile and received sustained 100mph winds. The wind produced waves of approximately 4 ft and a run-up of about 6 ft. As a result, the levee sides were severely eroded, even past the interior crown.

As previously stated, personnel with the Jacksonville District **Corps** of Engineers were also contacted and asked for information relevant to this literature review. Jacksonville district personnel **suggested** the use of 10ft of exterior freeboard and 7ft of interior freeboard. **This estimate is based on past experience** in the Everglades. However, Jacksonville District personnel stated that the exact freeboard amounts would vary depending on the specific reservoir.

Literature Review

4. SUMMARY

This memorandum summarizes one of the tasks completed in developing the Wave Run-Up model and includes the results of a literature review to search for site-specific information on freeboard requirements and the effectiveness of wave run-up models. The primary focus of the literature review was identifying information on procedures used to determine freeboard requirements and how the reservoirs have reacted to hurricane or strong wind conditions.

Several sources were examined to obtain data and information pertinent to this task. Searches were conducted using the several search engines, databases and websites. In addition, personnel from several agencies were contacted for information.

The information obtained during this literature review included both freeboard requirements and site-specific information on procedures used to determine freeboard and how the reservoir reacted to hurricane or high wind events, i.e., was the freeboard sufficient. Freeboard requirements established by the USACE and FEMA were reviewed and summarized. Unfortunately, very little site-specific information was found during the literature review.

5. REFERENCES

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